RANDOM VARIABLES AND A SOVEREIGN GOD

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0) Introduction

Are random variables just models created by mathematicians to explain otherwise presently unexplainable phenomena in the real world; or are they analogs of events in the real world which are truly random? I have considered this question as a mathematician who, having taught probability and statistics for 20 years, continues to be interested in the empirical foundations of mathematics. But I am equally interested in the question as a Christian mathematician attempting to integrate my faith with my discipline. If there are random events, does that contradict the Biblical teaching of God's sovereignty?

In this paper, I take a brief look at the history of conflict between the concepts of chance and divine activity. Then I discuss some evidence for randomness in the universe, after which I present philosophical and theological views from four different scientists on this subject. Finally I conclude with some questions and some observations concerning those questions.

1) Historical Perspective (1, chapter 1-3)

An interest in "chance events" appears to be at least as old as the recorded history of man. There is evidence that games of chance were played in Egypt as long ago as 3500 B.C. These were played on boards using markers and using an animal astragalus (a bone in the heel) as the random device. Gaming perhaps developed from these games of chance, in which the random device was retained but the board discarded. The astragalus continued to be used in both types of games at least to the time of the Roman empire, during which period it appears to be evolving into the modern die.

Equally ancient is the practice of sortilege, that is, the use of random devices to interrogate the gods. Four, or perhaps five, astragali were used in the Greek and Roman temples to learn the will of the gods. Drawing lots was a common means of sortilege, described in both secular and Biblical history. What is interesting, and somewhat puzzling, is that the same means were used in taverns, eating houses, or elsewhere to while away idle hours as were used in the temple, religious gatherings or by the individual to find God's (or the god's)will; in the former because they gave random results and in the latter because God (or the gods) directed them.

The Christian church has a spotty record on divination by "casting lots". Apparently it was common practice among the first Christians, since they chose Judas replacement by lot (Acts 1:26). As recently as the 18th century, John Wesley writes "at some rare time, when I have been in great distress of soul, or in utter uncertainty how to act in an important case which required a speedy determination, after using all other means that occured, I have cast lots, or opened the Bible (apparently a random opening). And by this means I have been relieved from that distress, or directed in that uncertainty." (2, p. 316). Wesley defended this practice, not by Biblical injunction or

example, but "since I found much benefit, and no inconvenience" (2, p. 317) and it was not expressly forbidden by Scripture.

On the other hand, the church very early took a strong stand against gambling and sortilege, probably because these methods were such an integral part of pagan life and worship. (There is no specific condemnation of either gambling or sortilege in the Scriptures, as far as I can find.) The Greeks believed in 3 categories of events:

(1) ones the gods could alter at will

(2) ones governed by natural law

(3) chance events

Cicero, in his Book II, argues for the existance of blind chance and seeks to divorce all pragnostication and soothsaying from interpretation of the will of the gods. The concept of randomness was rejected however, by the Christians, at least by the time of Augustine, if indeed his writings are characteristic of Christian thought of the time. He believed that nothing happened by chance, everything being minutely controlled by the will of God. If events appear to occur at random it is because of the ignorance of man and not the nature of the events. My experience suggests that this represents the common view of the majority of Christians today. Perhaps it's one of those beliefs we will argue for rather than live by for as Dorothy Sayers has so pointedly observed: "even the most thorough-going philosophic determinist will swear at the maid, like any good Christian, when the toast is burned."

2) Chance In Nature

I have been calling the outcomes of throwing astragali (or dice) or of drawing lots random events. Some would argue that the outcome of a throw of dice is not random, that it is determined by the initial and boundry conditions, and that we call it random only because of our ignorance of these conditions. However, this is a philosophical argument based on the assumption of determinism, that is, that a given set of conditions must necessarily result is a unique event. I would argue that there is no way to test this empirically since there are too many variables and the change in anyone sufficient to produce a change in the outcome is so small as to be within the range of experimental error. Experimental evidence certainly supports the assumption that the outcome of a throw of dice is random.

Let's consider another concept of randomness. Suppose that tomorrow I decide to go for a walk. In the course of my walk, I approach a house on which carpenters are installing a new roof. Just as I get there, a workman slips and drops his hammer, which hits me on the head. Is that a random event? I claim it is. One might explain my presence near that house by a deterministic sequence of events, and one might explain the events that led up to the hammer falling by a deterministic sequence. But what about the intersection of these two independent sequences of events at just the right (or wrong from my viewpoint) moment. We call this an accident, which is just another name for chance event.

Laplace would have viewed both of these examples quite differently. Living

at a time in history when the laws of theoretical mechanics seemed to be so successful in predicting outcomes of physical systems, he was convinced that they applied exactly and universally. In fact he said that if he had a being of infinite computational capacity, such a "mathematical demon", given the position and velocity of every particle in the universe at a particular instant of time, could specify the exact state of the universe at any subsequent time. It is important to note that this conclusion does not rest on the existence of the demon but on the assumption of complete determinacy.

This view was shattered in the early part of the 20th century by Heisenberg's indeterminacy principle and the development of quantum mechanics. A particle of atomic or subatomic size, such as an electron, does not act like the idealized billiard ball of classical mechanics. The classical billiard ball always follows a unique path when it is hit a certain way by the cue. However, quantum mechanics says that if you hit an electron a certain way, using your sub-microscopic cue, all you can predict is a family of paths the electron might take, each with a certain probability. There is no way to know which path it will take in any given instance, that is, it is a random event.

Quantum mechanics resulted from the indeterminacy principle formulated by Heisenberg. It states that it is impossible to know precisely both the position and the velocity of a small particle simultaneously. This of course destroys Laplace's view of determinism since his demon could not have had the initial conditions necessary to begin his calculations.

It is important to note that quantum mechanics has had overwhelming experimental support. It has been eminently successful in describing and predicting physical phenomena. Does this mean that at the very basis of our physical world is essential randomness? When Albert Einstein heard of Heisenberg's work, his reaction was "Does God throw dice." On the other hand William Pollard, a nuclear physicist says: "Whether we like it or not, it seems to be a world in which indeterminacy, alternative, and chance are real aspects of the fundamental nature of things, and not merely the consequence of our inadequate and provisional understanding." (4, p.54)

We could site many other evidences of randomness in nature that would seem to confirm Pollard's statement. Radioactive decay, turbulence in fluid flow, gene mutations, sex determination (and many other aspects of heredity), amino acid sequences in a polypeptide; all of these seem to show nature working at random. Levinson said "whole sections of astronomy and physics are full of statistics, and they are full of it not because they like statistics, but because it appears that nature does." (3, p.6) This then gives evidence to Jeffrey's statement "...the true logic of this world is the calculus of probabilities." (5, p. 1)

3) Chance and Necessity

About a decade ago, the following appeared in the New York Times: "For some time now, the unpleasant idea has been dawning on mankind that it may owe its existance to nothing but a roll of some cosmological set of dice. But until recently, hard proof has been missing and the larger philosophical implications have remained obscure. What Jacques Monod is here to say in his difficult but important book is that the proof is now available and the implications may necessitate a revolution in human thought." The subject was

Jacques Monod's new book entitled Chance and Necessity (6). Monod was a Nobel Prize-winning French biologist and his book has been a major influence in propagating a "philosophy for a universe without causality." I shall try to briefly summarize his message.

He says: "The thesis I shall present in this book is that the biosphere does not contain a predictable class of objects or of events but constitutes a particular occurance, compatible indeed with first principles, but not definable from those principles and therefore essentially unpredictable." (6, p.43) He rejects any purpose in the universe. "The cornerstone of the scientific method is the postulate of objectivity. In other words, the systematic denial that 'true' knowledge can be got at by interpreting phenomena in terms of final causes, that is to say, of 'purpose'." (6, p.21) Although he admits the "teleonomic character of living organisms," he explains it in completely mechanistic terms.

Monod sees two basic principles at work to produce any existing state. One is chance, by which all innovation occurs. The other is genetic invariance which then faithfully reproduces the cell over and over again. His final position (perhaps ultimate faith) is expressed as follows: "...chance alone is at the source of every innovation, of all creation in the biosphere. Pure chance, absolutely free but blind, at the very root of the stupendous edifice of evolution: this central concept of modern biology is no longer one among other possible or even conceivable hypotheses. It is today the sole conceivable hypothesis, the only one that squares with observed and tested facts. And nothing warrants the supposition--or even hope--that on this score our position is likely ever to be revised." (6, p. 112)

4) Chance and Providence

A decade earlier, William Pollard, an atomic physicist and ordained Christian clergyman, had grappled with the problem of randomness in the universe from a Christian perspective. His ideas were published in his book entitled Chance and Providence (4). As a scientist, he was trained to view the world as objective. However, as a Christian, he believed that God acts in a providential way in the events of history. So he struggled with the intellectual problem of reconciling these apparently contradictory, or paradoxical, views.

Pollard rejects a deterministic universe. He says "the case which is really typical of science is one in which the laws of nature first define several possible states which a system under consideration may occupy in full conformance to them, and secondly, in which they determine the probabilities that in individual instances the system will choose each of these several possible states in response to a given set of forces or causes acting upon it. Thus the typical situation is an indeterminate one involving alternatives and latitude." (4, p. 60) He concludes that "chance appears to be essential to scientific knowledge, not because of any merely temporary inadequacy of science, but because the world which science investigates is made in a certain way." (4, p. 87)

Pollard's view of providence is based on "the God who acts in human life and human history. In every situation and in every event throughout the whole of His creation, animate and inanimate alike, He acts in might, in power, and in mercy. He chastens in judgment and heals in redemption. As history unfolds,

it proceeds in accordance with the mysterious purpose of His will." (4, p. 85)

Although chance and providence appear to be contradictory, Pollard sees chance as the vehicle through which God's providence can manifest itself. "One and the same event can equally well be regarded as under the full sway of all laws of nature and natural causality and at the same time under the full sway of the divine will. The reason is that the laws of nature prescribe only the chance or probability of the event under the given set of circumstances in which it occurred. But a knowledge of this probability in no way affects the providential character of the event, which depends only on the circumstance that that particular possibility was the one which actually did occur in the historical sequence of which it was a part ... What is labeled chance in one context can without contradiction manifest the will of God acting in judgment or in redemption in the other. It is in this way that a world ruled by God and responsive to His will can be at the same time a world capable of scientific description in terms of natural law and natural causality." (4, p. 94) He arrived at the following conclusion: "These considerations make it clear that the one characteristic of the scientific description of the world which we require in order to have the kind of world in which the Biblical view can be true is the description of phenomena in terms of chance and probability. ... Those Christian writers who strive so laboriously to prove that the events of history could not have been the result of chance only play into the hands of their secular opponents. To Einstein's famous question expressing his abhorrence of quantum mechanics, 'Does God throw dice?' the Judeo-Christian answer is not, as so many have wrongly supposed, a denial, but a very positive affirmative. For only in a world in which the laws of nature govern events in accordance with the casting of dice can the Biblical view of a world whose history is responsive to God's will prevail." (4, p. 97)

5) Statistical Determinism

David Dye, another Christian physicist and author, accepts the evidence of randomness in nature, but is more cautious in rejecting causality. He says "There are now strong reasons to accept the notion that ... all physical laws must be framed as probability statements. It may be that nature behaves statistically according to the principles of chance. But ... a statistical nature may be a much different thing from a noncausal, nonuniform, or irrational nature." (7, p. 40)

Although he recognizes that we can describe behavior of atomic systems only by means of probability statements, he goes on to say that "We do not agree that modern physics forces us to the type of statistical view that would deny uniformity or causality .... We consider it entirely consistent with all the facts to take a more moderate view of causality: to wit, causality operates according to statistical laws." (7, p. 45) He is referring to, for example, the law of large numbers which says that, even though a single flip of an honest coin is random, the proportion of heads in 1,000,000 flips is very close to 1/2. Or the central limit theorem which guarantees that the mean of a sufficiently large sample, from almost any kind of distribution, will be approximately normally distributed. Thus, he would opt for a "statistically determined interpretation of causality." (7, p. 47)

6) Chance and the Life Game (9)

One more author who has made significant contributions to the question at hand is A. R. Peacock, a physical biochemist and theologian. In his book Creation and the World of Science (8), Peacocke discusses the views of both Monod and Pollard. He says: "It will transpire that, by and large, I agree that chance, appropriately defined, is the means whereby the potentialities of the universe are actualized but that from this I shall draw conclusions different from those of Monod." (8, p. 86) Coming from a Christian perspective, he disagrees with Monod's assumption of purposelessness in the universe. Also, his concept of randomness is closer to that of Dye than Monod or Pollard. For example, he says "the involvement of chance at the level of mutations does not, of itself, preclude these events manifesting a law-like behavior at the level of populations or organisms." (8, p. 94) (again the law of large numbers). Peacocke rejects Pollard's view of providence through chance events as "not capable of carrying the theological weight, in relationship to Biblical tradition, which he places on it." (8, p. 96)

Peacocke makes an additional contribution to relating God and chance which is worth noting. "If we propose that the world owes its being to a creator God then I see no reason why God should not allow the potentialities of his universe to be developed in all their ramifications through the operation of random events; indeed, in principle, this is the only way in which all potentialities might eventually, given enough time and space, be actualized. Or to change the metaphor, it is as if chance is a search radar of God sweeping through all the possible targets available to its probing." (8, p. 95)

7) Questions and Observations

What can we conclude from all of this? We might conclude with the writer of the Ecclasiastes that "time and chance govern all" (Ecc 9:11 NEB).

Since our present understanding of the universe seems to require a great deal of necessary randomness, I find it consistent as a Christian to believe that that is the way God built the universe. Furthermore, Christians have argued for 3 centuries that the phenomenal success of mathematics in understanding and predicting in the physical world was evidence of a created order. Does not this logic apply equally well when the mathematics is probability theory or mathematical statistics as when it was classical differential equations?

How does this square with the Christian's belief in God's sovereign control of the universe? Monod's concept of randomness rules out God. Pollard's concept makes room for God's providence. One could argue for the application of the principle of complementarity as Donald MacKay (10) does in dealing with the problem of free will. At present I lean toward the latter solution (or explanation) for lack of a better approach. At any rate, I suggest that God is free to build any kind of world he wishes to and our present knowledge seems to suggest that he chose to build one in which randomness plays an important part.

What are some consequences of this view? I think an important one is its effect on Christian theology. Just as the mathematics and science of Kepler and Galileo forced medieval Christian theology to change and update its concept

of both God and his universe for the better, so the concept of randomness as observed in modern physics and biology can have the same effect. Hopefully, this would also close the great gulf between Christians who insist that God created by fiat and those who believe that God had a lot more lattitude in performing his creative activities.

Perhaps a fitting conclusion to these remarks is Levy's 9th law: "Only God can make a random selection."

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